

Q1 : Choose the best answer

[5 Marks]

1- What is the carrier frequency if both used frequencies in BFSK are $f_1=200$ kHz and $f_2=300$ kHz

- a. 100 kHz
- b. 200 kHz
- ☒ c. 250 kHz
- d. 300 kHz

2- Find the minimum hamming distance for correcting 2 errors

- a. $d_{\min} = 2$
- b. $d_{\min} = 3$
- ☒ c. $d_{\min} = 5$
- d. $d_{\min} = 7$

3- In MASK system with each amplitude represents 4 bits, the system has levels.

- a. 4
- b. 8
- ☒ c. 16
- d. 34

4- In delta modulation increasing the size of the step (σ) will .

- ☒ a. Increase quantization noise
- b. Increase slope overload noise
- c. decrease quantization noise
- d. both a and b

5- A system hamming codes to send hexadecimal digits (0 – F), using the equations in Q4, what will be the syndrome for a received codeword that shows the dataword is '2' instead of 'A'?

- ☒ a. $S = (0, 1, 1)$
- b. $S = (1, 0, 0)$
- c. $S = (1, 0, 1)$
- d. $S = (1, 1, 0)$

Q2 : Short answers

[6 Marks]

1.5 a- List the three characteristics of analog wave

- 1- Amplitude
- 2- Frequency
- 3- phase

b- In synchronous transmission (long stream of bits), how can both transmission ends synchronize?

- 1- Embedded sync within the coding.
- 2- Separate clock line for sync.

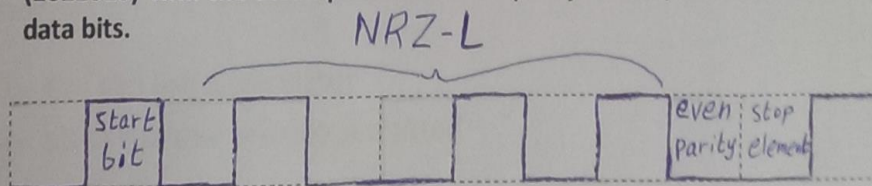
c- What are the two reasons for modulating analog data into analog signal?

- 1- Higher frequency can give more efficient transmission
- 2- Permits frequency division multiplexing

d- What is the PCM code for the following set of PAM values 1.7, 5.2, 10.3, and 2.9 (the system has 16 levels).

PAM	1.7	5.2	10.3	2.9
PCM	1	5	10	2
Encoded	0001	0101	1010	0010

e- Draw the Asynchronous signal used to send the following block of bits as the data (1011010) with the assumption that even parity is used; draw all the control and data bits.



Q3: Cyclic Redundancy Check

[9 Marks]

a- For the dataword ($D = 11010101$) and CRC with polynomial $x^3 + x^2 + 1$ as the generator, calculate the codeword (use the binary method) 1101

$$h - k + 1 = 4 \rightarrow h - k = 3$$

$$\begin{array}{r}
 10000110 \\
 1101 \overline{) 11010101000} \\
 \underline{1101} \\
 0000 \\
 0000 \\
 \underline{0001} \\
 0000 \\
 \underline{0010} \\
 0000 \\
 \underline{0101} \\
 0000 \\
 \underline{1010} \\
 1101 \\
 \underline{1110} \\
 1101 \\
 \underline{0110} \\
 0000 \\
 \underline{110}
 \end{array}$$

$$\text{Code word} = 11010101110$$

b- For the codeword ($C = 101001110101$) with a divisor ($P = 10111$), what are the values of k , n and r ? And is the codeword correct? (use the polynomial method and show your work)

$$h - k + 1 = 5 \rightarrow h - k = 4$$

$$h = 12 \rightarrow 12 - k = 4$$

$$k = 8, r = 4$$

$$C = X^{11} + X^9 + X^6 + X^5 + X^4 + X^2 + 1$$

$$P = X^4 + X^2 + X + 1$$

The code word isn't correct

$$\begin{array}{r}
 X^7 + X^4 + X^3 + X + 1 \\
 X^4 + X^2 + X + 1 \overline{) X^{11} + X^9 + X^6 + X^5 + X^4 + X^2 + 1} \\
 \underline{X^{11} + X^9 + X^8 + X^7} \\
 X^8 + X^7 + X^6 + X^5 \\
 \underline{X^8 + X^6 + X^5 + X^4} \\
 X^7 + X^4 + X^4 + X^2 \\
 \underline{X^7 + X^5 + X^4 + X^3} \\
 X^5 + X^4 + X^3 + X^2 \\
 \underline{X^5 + X^3 + X^2 + X} \\
 X^4 + X + 1 \\
 \underline{X^4 + X^2 + X + 1} \\
 X^2
 \end{array}$$

$$d_0 \oplus d_1 \oplus d_3 = p_0$$

$$d_0 \oplus d_2 \oplus d_3 = p_1$$

$$d_1 \oplus d_2 \oplus d_3 = p_2$$

a- Using the equations method, find and fix (if there is) the error for the following codewords ($C_1 = 1011001$, $C_2 = 0001111$).

$$C_1 = \begin{matrix} d_0 & d_1 & d_2 & d_3 & p_0 & p_1 & p_2 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 \end{matrix}$$

$$S_0 = d_0 \oplus d_1 \oplus d_3 \oplus p_0$$

$$S_0 = 1 \oplus 0 \oplus 1 \oplus 0 = 0$$

$$S_1 = d_0 \oplus d_2 \oplus d_3 \oplus p_1$$

$$S_1 = 1 \oplus 1 \oplus 1 \oplus 0 = 1$$

$$S_2 = d_1 \oplus d_2 \oplus d_3 \oplus p_2$$

$$S_2 = 0 \oplus 1 \oplus 1 \oplus 1 = 1$$

$S = 110$; the error in d_2

$$C_1 = 1001001$$

$$C_2 = \begin{matrix} d_0 & d_1 & d_2 & d_3 & p_0 & p_1 & p_2 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{matrix}$$

$$S_0 = d_0 \oplus d_1 \oplus d_3 \oplus p_0$$

$$S_0 = 0 \oplus 0 \oplus 1 \oplus 1 = 0$$

$$S_1 = d_0 \oplus d_2 \oplus d_3 \oplus p_1$$

$$S_1 = 0 \oplus 0 \oplus 1 \oplus 1 = 0$$

$$S_2 = d_1 \oplus d_2 \oplus d_3 \oplus p_2$$

$$S_2 = 0 \oplus 0 \oplus 1 \oplus 1 = 0$$

$S = 000$; there is no error

b- Using the equations method, generate the codeword for the dataword ($D = 1101$)

$$p_0 = d_0 \oplus d_1 \oplus d_3 \Rightarrow 1 \oplus 1 \oplus 1 = 1$$

$$p_1 = d_0 \oplus d_2 \oplus d_3 \Rightarrow 1 \oplus 0 \oplus 1 = 0$$

$$p_2 = d_1 \oplus d_2 \oplus d_3 \Rightarrow 1 \oplus 0 \oplus 1 = 0$$

$$C = 1101100$$

c- For the Hamming code system $C(15, 11)$ find k , n , r , and d_{min}

$$n = 2^m - 1; n = 15, k = 11$$

$$r = m; n - k = r$$

$$r = 15 - 11 = 4$$

$$\text{for checking} \rightarrow n = 2^4 - 1 = 15$$

$$\& 15 = 2^m - 1 \rightarrow m = 4$$